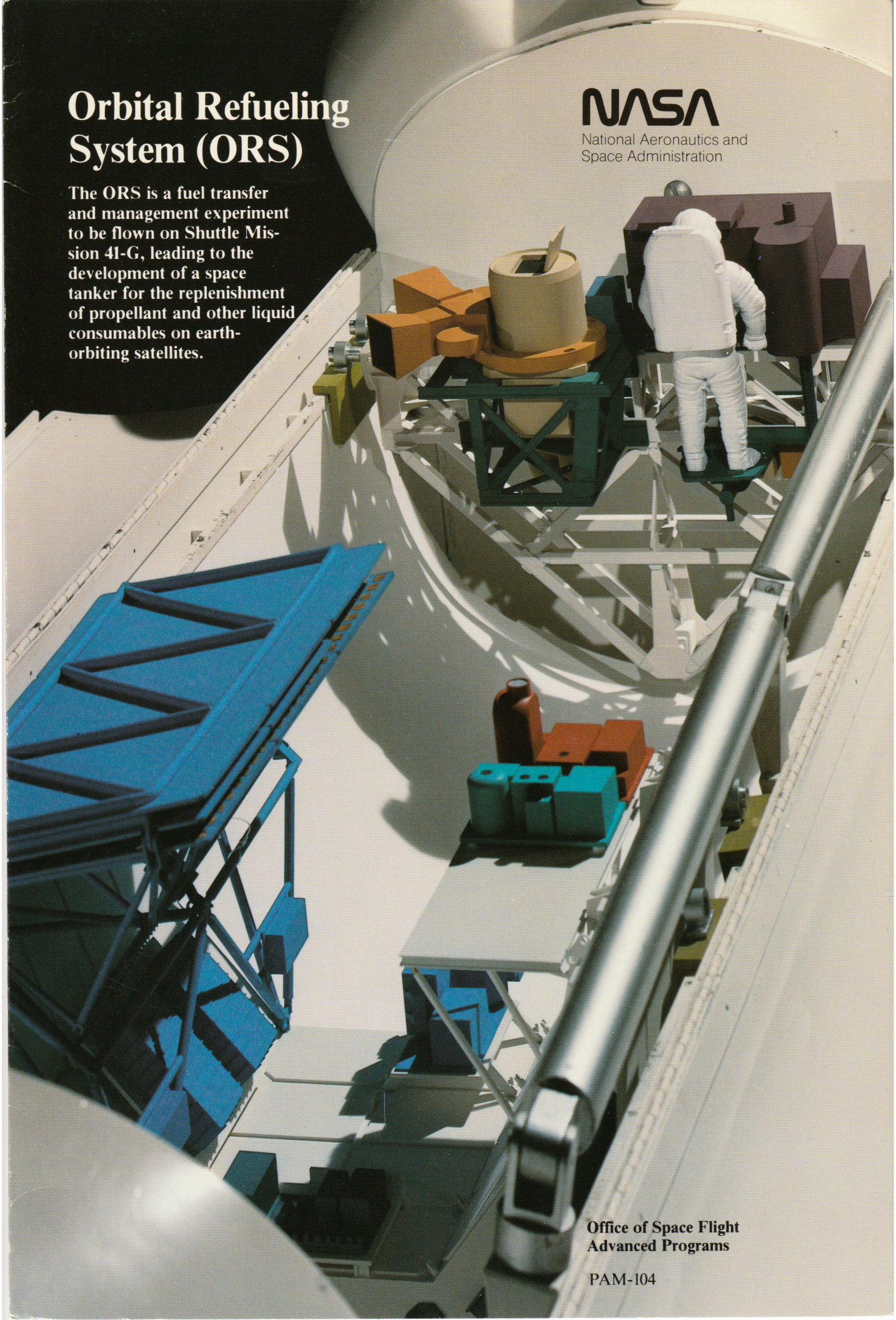
Orbital Refueling System (ORS)

The ORS is a fuel transfer and management experiment to be flown on Shuttle Mission 41-G, leading to the development of a space tanker for the replenishment of propellant and other liquid consumables on earth-orbiting satellites.

NASA
National Aeronautics and Space Administration



Office of Space Flight
Advanced Programs

PAM-104

Orbital Refueling Objectives

- Develop and demonstrate the equipment and procedures for a hydrazine fuel transfer system
- Develop and demonstrate the tools needed to interface with existing satellites to accomplish fuel transfer. (Current satellites are not designed for on-orbit refueling.)
- Develop and evaluate specific procedures to refuel present satellites of the Landsat type

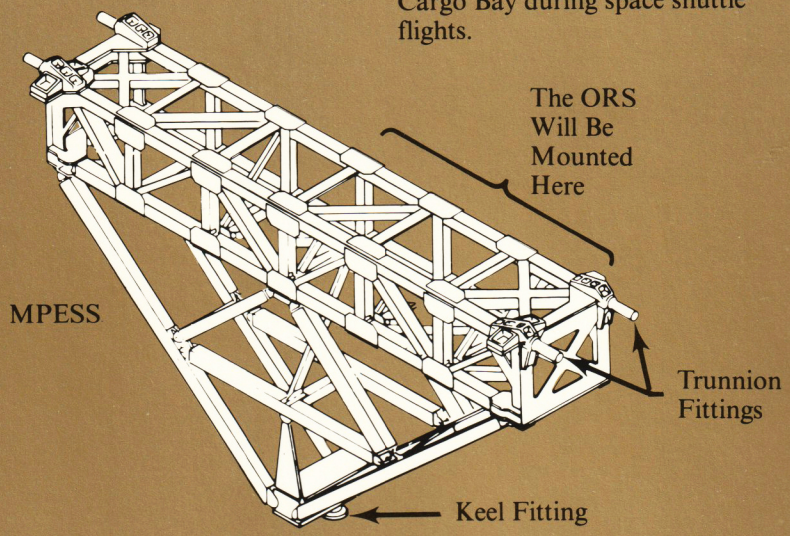
System Description

The ORS consists of five major subsystems:

1. Structural
2. Fluid
3. Avionics
4. Thermal
5. EVA Tools

Structural Subsystem

The ORS is supported by the Mission Peculiar Support Structure (MPESS) in the Orbiter Cargo Bay during space shuttle flights.

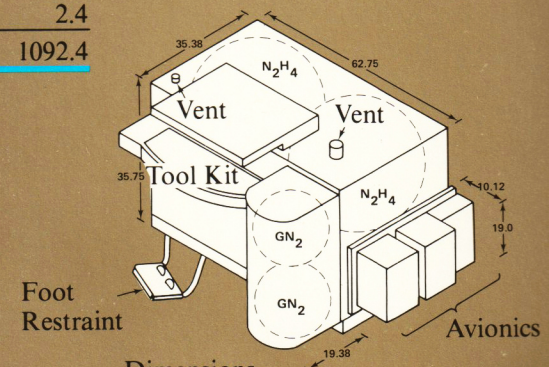


Fluid Subsystem

The ORS tankage unit (with its fuel tanks, pressurant tanks, piping, valving, heaters and avionics) is mounted on the MPESS in the Cargo Bay. The system shown below is the prototype unit which was built to develop procedures and gather engineering data. In the test configuration it is capable of multiple transfers of approximately 200 pounds of hydrazine fuel. It can be modified to deliver approximately 500 pounds of fuel to an orbiting satellite by a fuel line connected with a hydrazine servicing interface tool set. The system will be interfaced to the Orbiter general purpose computer, and analog channels are available for data monitoring. Control is from the Aft Flight Deck. An extra-vehicular crew member performs fuel line connection tasks.

Tankage Unit Weights

Component	Weight (Lbs)
Tankage Unit, Dry	851.0
Gaseous Nitrogen Supply	32.4
Tank 1	
Propellant	90.0
Gaseous Nitrogen	6.6
Tank 2	
Propellant	110.0
Gaseous Nitrogen	2.4
Total, Nominal	1092.4

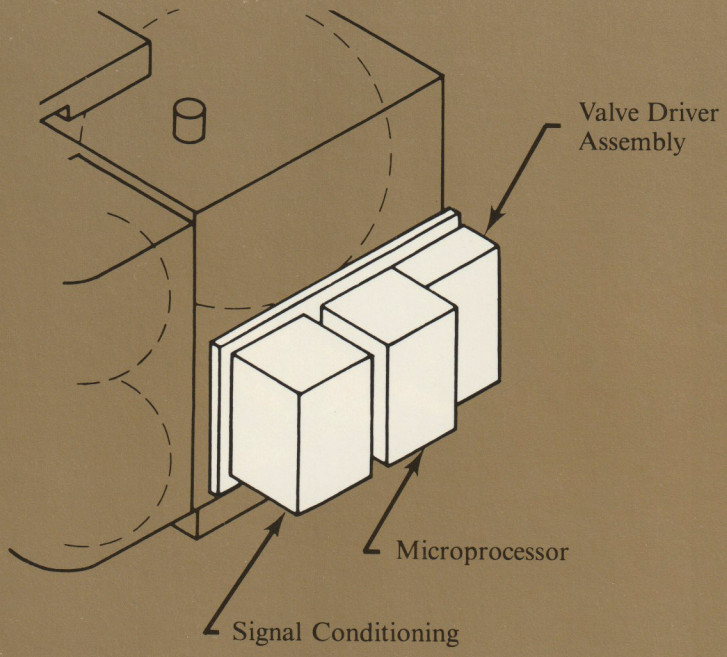


Dimensions in inches

Avionics Subsystem

The avionics equipment, consisting of a signal conditioner unit, valve driver assembly and microprocessor, provides control and monitoring of ORS operations from the Shuttle Orbiter Aft Flight Deck.

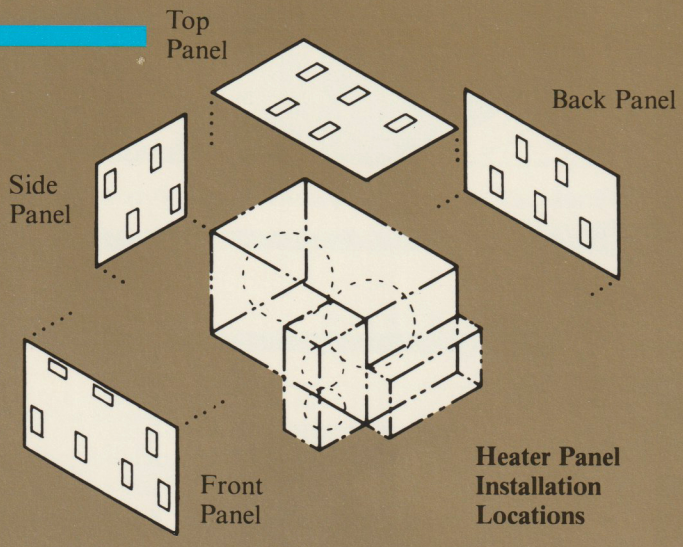
- **Electrical Power**
- **Control**
  - Orbiter standard switch panel
  - ORS computer and keyboard display unit
  - Orbiter CRT display
- **Instrumentation**
  - Pressure, temperature
  - Valve positions
  - Flow rates/quantities



Thermal Subsystem

The thermal equipment provides passive and active controls to maintain the fluid system in a safe temperature range.

The ORS heaters are located on the shroud panels. Heater patches contain redundant element systems, and each patch is thermostatically controlled.



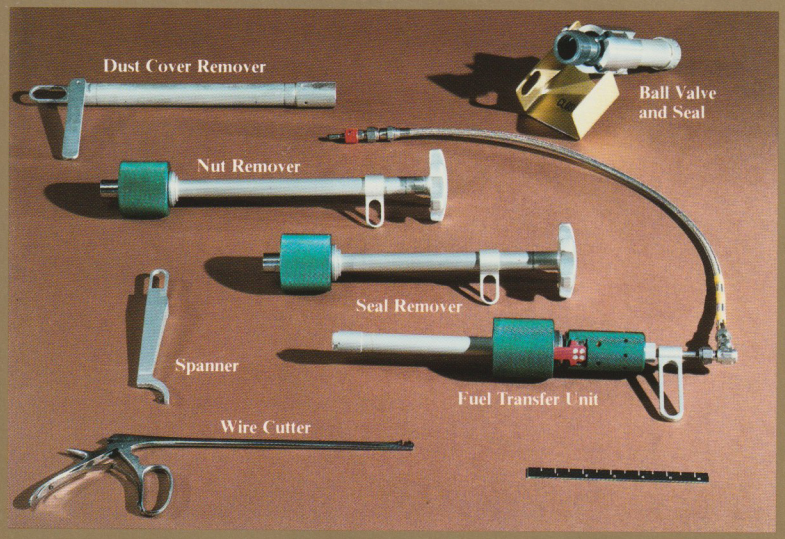
Heater Panel Installation Locations

EVA Tools Subsystem

The EVA tools are the unique hardware items required to:

- Permit access to the manual fill valve
- Provide redundant seals for crew safety
- Control fluid flow to satellite

The tool set consists of seven items designed for satellite engagement, valve opening and valve closing. The fuel transfer unit and valve, once engaged, become permanently attached to the satellite, thus providing a standard interface for refueling.



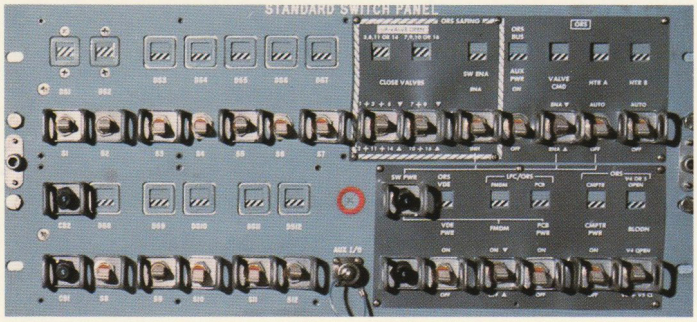
Control

Control of the ORS operation is through the Orbiter Aft Flight Deck (AFD) standard switch panel and the ORS Keyboard Display Unit (KDU). The KDU is the signal source and monitor for the ORS microprocessor. The system allows the crewman to command an event and verify the correct response on the KDU prior to enabling through the switch panel.

Independent backup and manual controls are provided for certain valves for "safing" and "blow-down" transfer.

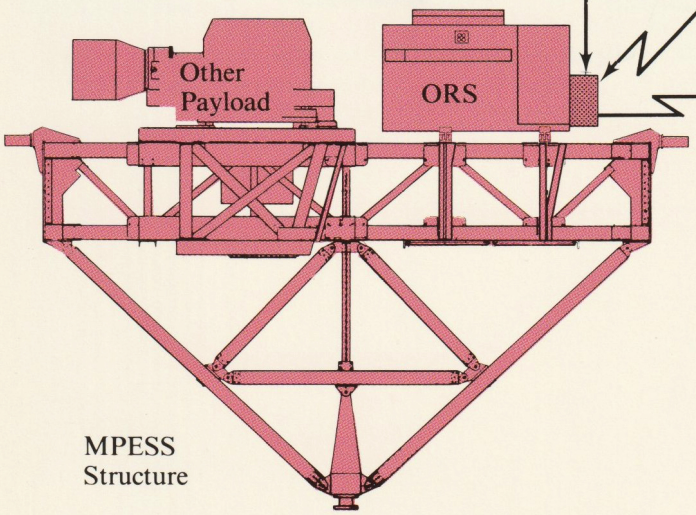
Thermostatically controlled circuits maintain the ORS operating temperature within the +60° F to +70° F range.

ORS Integration

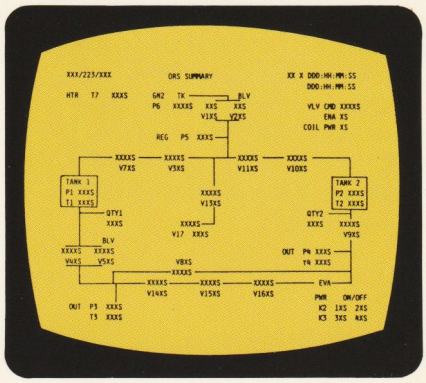


Orbiter Standard Switch Panel

ORS Portable Keyboard Display Unit

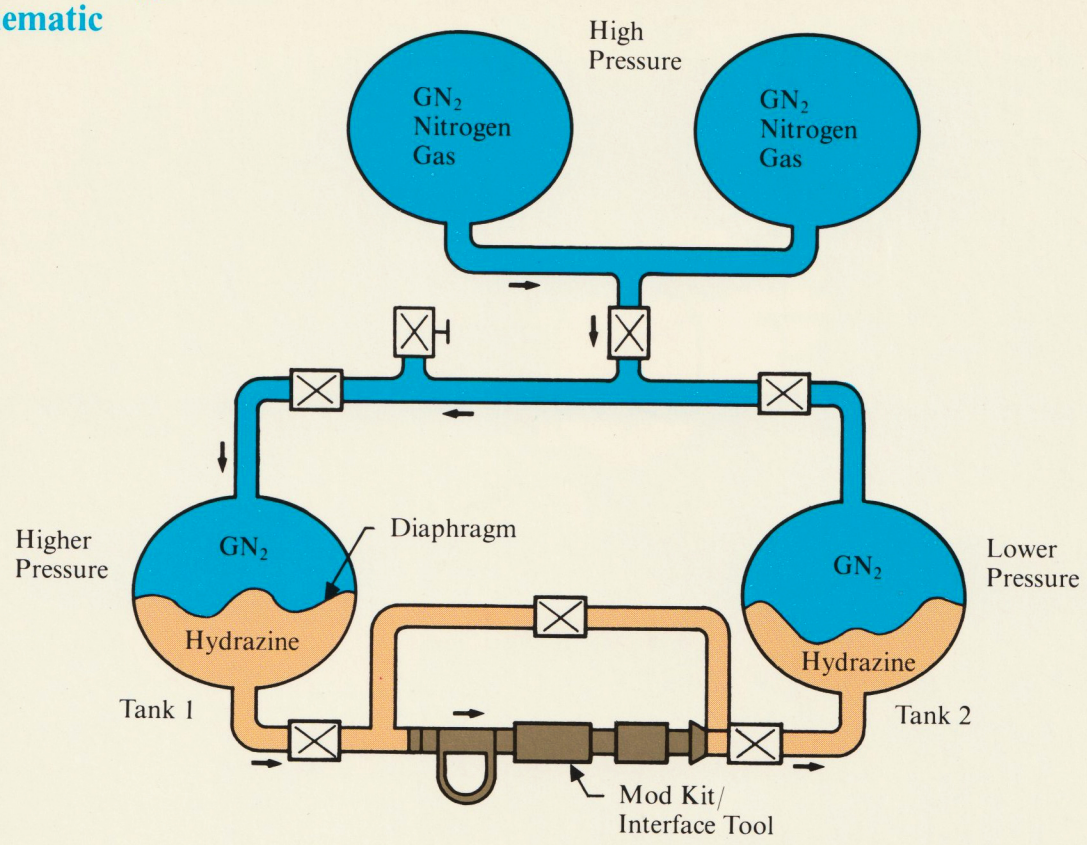


MPESS Structure



Orbiter CRT Display

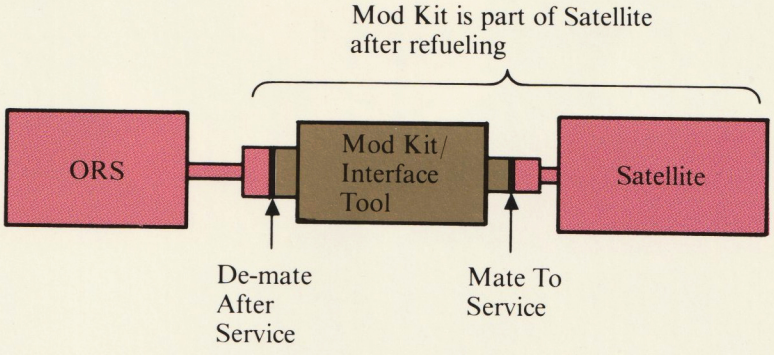
ORS Prototype Flow Schematic



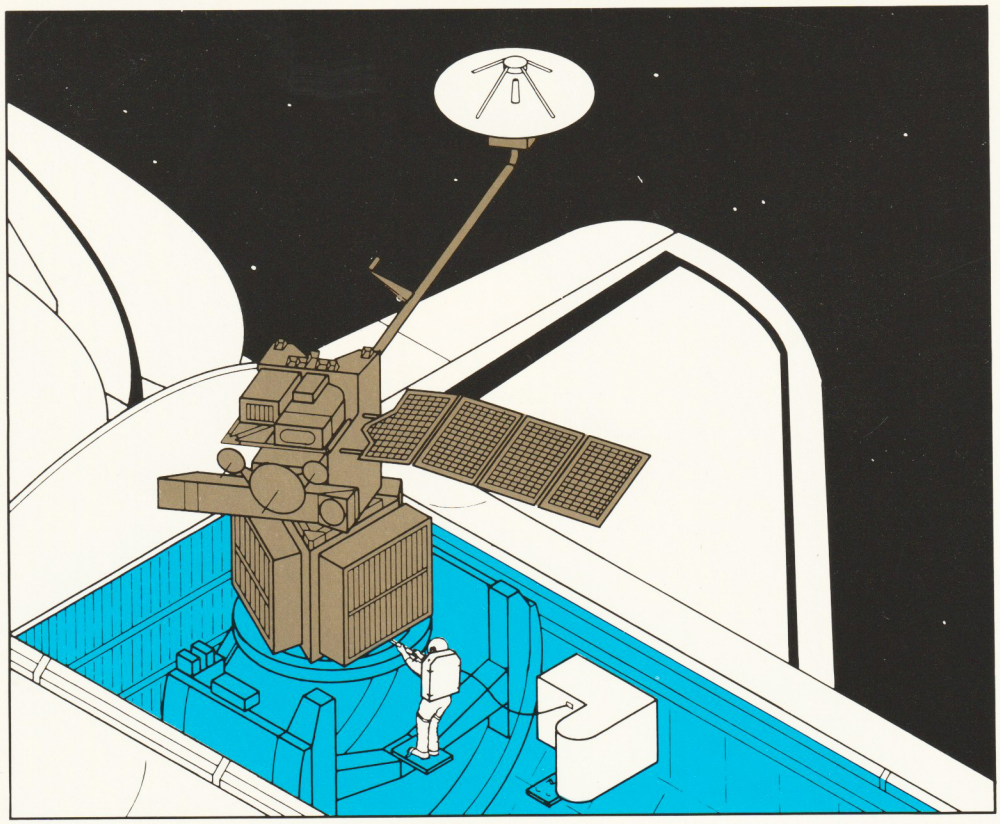
Proposed Satellite Refueling Interface

The ORS prototype unit is designed for multiple transfers of liquid hydrazine from one tank to another by use of the pressurization system to demonstrate the transfer techniques to be used for satellite refueling.

In the ORS prototype configuration, the "second" tank simulates that of the satellite to be refueled. Tank quantities, pressures, flow rates, temperatures, and valve positions are monitored and controlled from the aft flight deck.



Landsat-D Refueling



Landsat-D could utilize the ORS equipment and procedures for propellant replenishment.

Future Satellite Refueling

Routine refueling of future satellites (such as the Gamma Ray Observatory) is being planned, with special emphasis on the interface aspects. Unlike the current satellites, the future satellites will be designed for on-orbit refueling, thus facilitating the "hookup" through a standard interface.

NASA will develop and provide a 5000-pound capacity tanker system, which will fit in the Orbiter Cargo Bay, for refueling satellites in the 1990's.

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